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26 March 2017

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March 26, 2017

Abstract

This study examines the responses of some of the UK transportation, travel and leisure, and oil and gas firms to oil price changes. Fama-French-Carhart's (1997) four-factor asset pricing model is augmented with the oil price risk factor to study the association of oil and stock prices of 25 firms over the period from January 1998 to December 2012. The extent of the exposure of UK transportation and travel and leisure firms is generally negative but it is particularly significant for a number of firms including delivery services, travel and tourism, and airlines. Oil price risk exposures of UK oil and gas companies are generally positive and significant. With the aid of asymmetric and scaled specifications, some firms show strong evidence of asymmetry in the reaction of stock returns to changes in the price of oil comprising travel and tourism, airlines, and integrated oil and gas. Moreover, the results document that oil price risk exposures vary over time. In particular, the global recession of 2008 has significantly contributed to the oil price risk exposure of travel and tourism and integrated oil and gas firms. These results should be of interest to financial analysts, corporate executives, regulators and policy makers.

Keywords: Oil Price, Stock returns, Asset pricing
JEL classification: G12, Q31

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1 Introduction

Following the marked increase in oil price in 1970's and the recent 2008's economic crisis, researchers have scrutinized the oil price instability in order to realize its economic impact. In light of this, a vast number of studies have examined the macroeconomic influences of oil price fluctuations (for example, Hamilton, 1983, 2003, Kilian, 2008a,b, Kilian and Park, 2009). One category of these studies concentrated on the response of financial markets, specifically equity returns, to oil price shocks. The subject was either addressed with the implication of aggregate stock market data for various countries or analysing the variation among the industries in one country(such as, Sadorsky, 1999, Apergis and Miller, 2009, Moya-Martínez et al., 2014, Phan et al., 2015, Zhu et al., 2016, among others).

Despite the overall drop in UK energy utilization that is met by the growing consumption of renewable sources, the UK's dependence on imported energy has returned to the 1970's levels. After being a net exporter in the period from 1994 to 2003 due to the increase in the production of the North sea, the UK has become a net importer of energy since 2004. The Office for National Statistics (ONS) reports that in 2015, a third of the UK's fuel imports were crude oil and half of these crude oil imports came from Norway while about 36% of it are imported from OPEC countries.[1] As oil is an essential input in the production of goods and services, an increase in oil prices is presumably to increase costs of production, which sequentially may reduce cash flows and consequently stock prices. Moreover, oil prices may affect stock ratings through the discounted future cash flow rates. Hiking oil prices may generate inflationary pressures that eventually lead to tightening central banks' monetary policies and thus increase interest rates. A change in interest rates has enormous implications on companies as it affects company financing through higher borrowing costs and lower market value compared to book value, which will harm a company's capacity to raise funds.

It is beneficial to note that not all companies would response in the same direction to fluctuations in oil prices. The way of stock price responses depend on the oil intensity of the company, oil producer or oil consumer. Therefore, the main contribution of this paper is investigating the impact of oil price changes and volatility on the monthly stock returns of 25 UK firms from three different sectors (transportation, travel and leisure, and oil and gas) over the period 1998:1 to 2012:12.[2] In addition to the different responses of the different types of firms, the reaction of

[1] http://visual.ons.gov.uk/uk-energy-how-much-what-type-and-where-from/

[2] These are specifically chosen due to the availability of long historical data and as they form two different sides of the market, consumers and producers of crude oil.

the firms' stock returns to increases in the oil price mat differ from that to falls in the oil price as proved by some of the studies that are done on the sectoral level (for example Park and Ratti, 2008, Arouri, 2011). Subsequently, the second contribution of this study is to scrutinize this impact: increases and decreases in the oil price and hikes and drops in oil price volatility.

The official declaration of UK in recession was in January 2009. The Office for National Statistics (ONS) has announced that the initial estimation of UK GDP indicated a reduction of 1.5% in the last quarter of 2008 preceded by a fall of 0.6% in the previous quarter. These figures showed that the famous definition of a recession - two successive quarters of declining economic growth had been met. ONS figures indicated a fall in the UK GDP by 2.4% in the first quarter of 2009 in comparison to the last quarter of 2008. The second quarter of 2009 showed another reduction in GDP by 0.7%, resulting in an overall drop in the level of GDP by 5.5% compared to the second quarter of 2008 (Vaitilingam, 2010). Hence, the final contribution that this study presents is the investigation of oil price risk exposure during global recession.

Results reveal that the extent of the exposure of UK transportation and travel and leisure firms is generally negative (negative coefficients on oil price return) but it is particularly significant for a number of firms including delivery services, travel and tourism, and airlines. However, oil price risk exposures of UK oil and gas companies are generally positive and significant. Moreover, some firms show strong evidence of asymmetry in the reaction of stock returns to changes in the price of oil; these comprise travel and tourism, airlines, and integrated oil and gas firms.

The structure of the remaining parts of the chapter is as follows. The theoretical background of the asset pricing model and the related empirical literature is documented in section 2. Section 3 illustrates the applied methodology that will be adopted; followed by the data used in section 4. The results are presented in section 5 and the chapter is summarized in section 6.

2 Literature Review

With the increasing acceptance that pricing factors other than the market portfolio, especially macroeconomic factors, should also be included in the asset pricing model, this has led to further improvements, prominently in the form of the arbitrage theory. With this multifactor specification as a starting point, a growing number of empirical studies have examined whether macroeconomic variables spec-

ify a source of consistent asset price risk at the market and industry level. Examples of the employed macroeconomic variables other than market portfolio are: industrial production, inflation, term structure, money supply, gold prices, interest rates, and foreign exchange rate (for example Poon and Taylor, 1991, Antoniou et al., 1998, Faff and Chan, 1998, Dinenis and Staikouras, 1998, Elyasiani and Mansur, 1998, Ryan and Worthington, 2004, Erdem et al., 2005, among others).

As oil prices have fluctuated wildly in recent decades, it seems sensible to extend the literature with research on the impact of these prices on stock market return. The theoretical framework for how increasing oil prices influence stock prices is set out in Huang et al. (1996). An increase in the price of oil, which, in the absence of the effects of entire substitution between the components of production, increases the cost of operating a business. As such, higher expected business costs, reduces cash flow. Since stock prices are discounted values of expected cash flows, therefore, a reduction in the cash flow causes a similar change in stock prices. The impact on a particular stock price would rely on whether the company is a net consumer or producer of oil. In addition, a change in oil prices affect stock returns through the discount rate. The expected discount rate consists of a combination of the expected inflation rate and expected real interest rate, both of which may be affected by the price of oil. Since oil is a commodity, rising oil prices are often indicative of inflationary pressures (Kilian and Lewis, 2011). Therefore, an increase in the expected inflation rate will cause the same change in discount rate, thus, a reduction in stock returns.

In contrast to the bulk of work examining the relationship between oil price shocks and macroeconomic variables, there have been fewer number of studies that investigate the exposure of equity returns to oil price changes. Many of them have examined the effect of oil price risk on the aggregate stock market (Chen et al., 1986, Hamao, 1988, Sadorsky, 1999, Kaneko and Lee, 1995, Apergis and Miller, 2009, Basher and Sadorsky, 2006, Driesprong et al., 2008, Jones and Kaul, 1996, Kilian and Park, 2009, Park and Ratti, 2008). Other attempts have looked at the impact of oil price changes on the stocks of individual sectors. Most of these articles at the industry level focus on the US oil and gas industry (Hammoudeh et al., 2004, Mohanty et al., 2013, Mohanty and Nandha, 2011a), Canadian oil and gas sector (Sadorsky, 2001, Boyer and Filion, 2007), the UK oil and gas industry (El-Sharif et al., 2005), the US transportation industry (Aggarwal et al., 2012), the US travel and leisure industry (Mohanty et al., 2014), 13 US industries (Elyasiani et al., 2011), 35 global industry indices (Nandha and Faff, 2008), transport sector equity returns in 38 countries (Nandha and Brooks, 2009), the UK sectors (El-Sharif et al., 2005),

Australian industry stock returns (McSweeney and Worthington, 2008), and 12 European sector indices (Arouri, 2011).

In literature, minor attention has been paid to scrutinizing the impact of oil price changes on individual firms. For instance, Manning (1991) analyzes the reaction of London-quoted oil company stocks to oil price changes over the period from 1986 to 1988 using weekly data. He finds a positive and significant relationship between oil price changes and stock returns of oil companies and concludes that the response to an increase in oil price is more significant for oil firms that are included in exploration than those of integrated oil firms.[3] A firm-specific study by Al-Mudhaf and Goodwin (1993) examines the returns from 29 oil companies listed on the New York Stock Exchange. Their findings suggest a positive impact of oil price shocks on actual returns for firms with significant assets in domestic oil production. Using multivariate co-integration techniques and a vector error-correction model, Lanza et al. (2005) examine the long-run financial determinants of the stock prices of six major oil companies: Bp (UK), Chevron-Texaco (US), Eni (Italy), Exxon-Mobil (US), Royal Dutch Shell (The Netherlands/UK), and Total-Fina-Elf (France). They find a significant oil risk premium. With the implication of Fama-French-Carharts four-factor asset pricing model augmented with oil price and interest rate, Mohanty and Nandha (2011a) estimate oil price risk exposures of 40 U.S. oil and gas sector. They find that oil price risk exposures vary considerably over time, and across firms in addition to industry subsectors. As an extension to their previous study, Mohanty and Nandha (2011b) employ the same methodology to investigate the relation between oil price movements and US transportation companies' stock returns. Their results suggest that oil price exposures of firms in the US transportation sector vary across firms and over time. Most of the previously mentioned studies are applied on the US sectoral industries or individual firms, and a scarce number of studies are implemented on UK industrial sectors. As an attempt to fill this gap in the literature, the present chapter investigates the impact of oil price return on the stock returns of 25 UK firms from the industrial transportation, travel and leisure and oil and gas sectors.

[3]Integrated oil and gas companies are business entities that take part in the exploration, production, refinement and distribution of oil and gas.

3 Econometric Methodology

The major concern of this study is to determine whether the crude oil price return and its volatility provide supplemental information beyond the generally accepted return generating factors such as FF-Carhart's (1997) factors, in describing industry and company stock returns. Therefore, the company excess stock return is estimated using the four factor FF-Carhart's (1997) model to investigate the sensitivity of the company stock returns to oil prices. In addition, tests for non-linearity in the relationship between oil price and stock price returns are conducted.

3.1 Firm returns and oil price changes

Following Narayan and Sharma (2011), Arouri (2011) and Elyasiani et al. (2011), the FF-Carhart's (1997) model is used to examine whether the firm stock returns are sensitive to oil price changes takes the following form:

$$\begin{aligned} R_{it} &= \beta_0 + \beta_m\, RM_t + \beta_1\, SMB_t + \beta_2\, HML_t + \beta_3\, Mom_t + \beta_{oil}\, Roil_t + \varepsilon_{it} \\ \varepsilon &\rightarrow N(0, h_{it}) \\ h_{it}^2 &= \alpha + \sum_{m=1}^{q} \beta_m \times \varepsilon_{i,t-m}^2 + \sum_{n=1}^{p} \gamma_n \times h_{i,t-n}^2 \end{aligned} \tag{1}$$

where R_{it} is the monthly return on price index i in excess of the yield of three month UK treasury bills, RM_t is the excess monthly return on the market portfolio, SMB_t is the difference in monthly return between a small cap portfolio and a large cap portfolio, HML_t is the difference in monthly return between a portfolio of high book-to-market stocks and one of low book-to-market stocks, Mom_t is the difference between the equal weighted average of the highest performing firms and the equal weighted average of the lowest performing firms, and $Roil_t$ is the monthly return on the oil price. ε_{it} is the idiosyncratic error term, which is assumed to be normally distributed with zero mean and conditional variance determined by a standard GARCH (q,p) process. Before implementing the GARCH methodology, it is crucial to scrutinize the residuals for signs of heteroscedasticity. Therefore, the Engle (1982) Lagrange multiplier (LM) test is employed to check for the existence of ARCH effects. The $ARCH - LM$ test results for the firm's stock returns are reported in Table 1.

The mean equation in model (1) might be an autoregressive (AR) process, a moving average (MA) process or a combination of both AR or MA processes, (ARMA)

process. The model that has the lowest Akaike information criteria (AIC)(Akaike, 1998) combined with significant coefficients for all its components will be the best model; this can vary from firm to another.

The variance equation includes two parts, $\varepsilon^2_{i,t-m}$ which is the ARCH term that presents the volatility from the period and $h^2_{i,t-n}$ that shows the previous period variance. To ensure positive variance, the conditions, $\beta_m \geq 0$ and $\gamma_n \geq 0$ are needed. In addition, to preserve a mean reverting variance process, the sum of both coefficients should be less than one.

For the firms that show no ARCH effects, the Newey and West (1987) estimator that accounts for serial correlation of unknown form in the residuals of a single time series is utilized. With the existence of heteroscedasticity and/or serial correlation, the OLS estimator is no longer efficient and estimated standard errors are incorrect.

3.2 Asymmetric response to oil shocks

3.2.1 Asymmetric specification

In this specification, hikes and drops in the oil price are differentiated according to the following:

$$\begin{aligned} Roil_p^+ &= max[0, Roil_t] \\ Roil_n^- &= min[0, Roil_t] \end{aligned}$$

where $Roil_t$ is the return on the price of oil at time t and $Roil_p^+$ ($Roil_n^-$) is the positive (negative) oil price change at time t. $Roil_p^+(Roil_n^-)$ assumes positive(negative) values each time variations are positive (negative) and zero otherwise.

To examine the asymmetric effects of oil price fluctuations, equation (1) is rewritten to include the nonlinear measures of oil price changes: $Roil_p^+$, and $Roil_n^-$ besides the other factors. The exposure to rises in oil price is tested to see if it is different from the exposure to oil price drops. Following Basher and Sadorsky (2006), Nandha and Faff (2008), Sadorsky (2008), and Arouri (2011), $Roil_p^+$ and $Roil_n^-$ are included in the model to help test these effects:

$$\begin{aligned} R_{it} &= \beta_0 + \beta_m\, RM_t + \beta_1\, SMB_t + \beta_2\, HML_t + \beta_3\, Mom_t + \beta_{oil}^+\, Roil_p^+ \\ &\quad + \beta_{oil}^-\, Roil_n^- + \varepsilon_{it} \\ \varepsilon &\rightarrow N(0, h_{it}) \\ h_{it}^2 &= \alpha + \sum_{m=1}^{q} \beta_m \times \varepsilon^2_{i,t-m} + \sum_{n=1}^{p} \gamma_n \times h^2_{i,t-n} \end{aligned} \tag{2}$$

Therefore, β_{oil}^{+} and β_{oil}^{-} are the coefficients that show the impacts of increases and decreases in oil price, respectively. If β_{oil}^{+} and β_{oil}^{-} are not statistically different from zero, then the contention of asymmetry has no support. The null hypothesis that $\beta_{oil}^{+} = \beta_{oil}^{-}$ is also tested.

3.2.2 Scaled specification

This specification takes into consideration the volatility of oil prices. The main expectations is that increases in oil price after a long period of stability in price, may have larger impacts on stock returns than those that are simply corrections to greater decreases in oil price during the previous month. The measure of oil price volatility is based on a generalized autoregressive conditional heteroscedasticity process of order one, GARCH(1, 1) that was first proposed by Bollerslev (1986). Hansen and Lunde (2005) argue that the best volatility models do not provide a significantly better forecast than the GARCH(1,1) model. Following Lee et al. (1995), Jiménez-Rodríguez and Sanchez (2005) and Arouri (2011) we estimate a GARCH(1, 1) model to predict oil price volatility. Daily oil price returns will be estimated using ARMA(1,1)-GARCH(1, 1) model that is stated as the following:

$$\begin{aligned} Roil_t &= \gamma_0 + \gamma_1 Roil_{t-1} + \xi_t + \gamma_2 \xi_{t-1} \\ \xi_t &\rightarrow N(0, \sigma_t) \\ \sigma_t^2 &= \lambda_0 + \phi_1 \xi_{t-1}^2 + \varphi_1 \sigma_{t-1}^2 \end{aligned} \tag{3}$$

The monthly oil price volatilities ($Voil$) are computed as the average of the daily conditional volatilities

$$Voil = \frac{1}{D} \sum_{t=1}^{D} \hat{\sigma}_t^2$$

Then, the scaled oil price increase ($Voil_p^+$) and the scaled oil price decrease ($Voil_n^-$) are computed using the following:

$$\begin{aligned} Voil_p^+ &= max[0, \hat{\xi}_t / \sqrt{Voil_t}] \\ Voil_n^- &= min[0, \hat{\xi}_t / \sqrt{Voil_t}] \end{aligned}$$

Then the model can be estimated using the following equation:

$$\begin{aligned} R_{it} &= \beta_0 + \beta_m\, RM_t + \beta_1\, SMB_t + \beta_2\, HML_t + \beta_3\, Mom_t + \beta^+_{Voil}\, Voil^+_p \\ &\quad + \beta^-_{Voil}\, Voil^-_n + \varepsilon_{it} \\ \varepsilon &\to N(0, h_{it}) \\ h^2_{it} &= \alpha + \sum_{m=1}^{q} \beta_m \times \varepsilon^2_{i,t-m} + \sum_{n=1}^{p} \gamma_n \times h^2_{i,t-n} \end{aligned} \tag{4}$$

The same hypothesis as in the previous section will be tested here, using the coefficients β^+_{Voil} and β^-_{Voil}.

3.3 Effects of oil shocks and recessions on UK firms

In order to investigate the impact of oil price returns on the UK firm's stock returns during the global economic recession of 2008, equation (1) is augmented with a dummy variable. The dummy variable D_1 which equals 1 during the global recession from December 2007 to June 2009. This dummy variable is interacted with the change in oil price variable *Roil* as follows:

$$\begin{aligned} R_{it} &= \beta_0 + \beta_D D_1 + \beta_m\, RM_t + \beta_1\, SMB_t + \beta_2\, HML_t + \beta_3\, Mom_t \\ &\quad + \beta_{oil}\, Roil_t + \phi_1 D_1 Roil_t + \varepsilon_{it} \end{aligned} \tag{5}$$

4 Data

To investigate the relationship between UK firms' stock returns and oil price changes, monthly data from 1998:01 to 2012:12 are employed. Monthly price indices for all the UK active firms are downloaded from the Worldscope Database published by Thomson Reuters. Data availability of all the transportation, travel and leisure and oil and gas producers companies are examined. The list is narrowed to include as many companies with sufficiently long data period as possible. As a result, the final sample comprises 25 UK companies that have relatively long histories.[4] The transportation industry is then grouped into subsectors that include transportation services (six firms) and delivery services (one firm). The travel & leisure sector is divided into subsectors, too. Travel & tourism (four firms) and airlines (two firms). Finally, the oil & gas producer companies are distributed into exploration & pro-

[4]These firms are specifically chosen due to the availability of long historical data and as they form two different sides of the oil market, consumers and producers of crude oil.

duction (nine firms) and integrated oil & gas (three firms).

As is customary in the financial literature, returns R_{it} are computed as $R_{i,t} = [ln(I_{i,t}) - ln(I_{i,t-1})]$, where $I_{i,t}$ is the price index of firm i at time t in excess of the yield of three month UK Treasury Bills (i.e. equivalent to the risk free rate). Stock market returns RM_t is the monthly market portfolio excess return on month t, measured as the return on the FTSE ALL Share Index minus the return on three month UK Treasury Bills; the market return is a proxy for changes in aggregate economic wealth that affect risk premia and expected returns (Fama and French, 1989, Ferson and Harvey, 1991). SMB_t is the difference in monthly return between a small cap portfolio and a large cap portfolio, HML_t is the difference in monthly return between a portfolio of high book-to-market stocks and one of low book-to-market stocks, Mom_t is the return on a zero investment portfolio long on winner and short on loser stocks. The data on the four FF-Carhart factors are from the University of Exeter Business School website.[5]

Regarding the oil prices, monthly prices of the West Texas Intermediate (WTI), expressed in US $/barrel terms from the US Energy Information Agency. The exchange rate between the US $ and the UK £ is used to convert the oil price into £ and the consumer price index CPI of UK is employed to adjust the nominal (dollar) price of oil.[6] Monthly returns of oil price are then calculated as the logarithmic difference of oil prices. Descriptive statistics for all firm returns' series (first difference) are summarized in Table 2. The other variables' descriptive statistics including oil price returns are reported in Table 3.

To predetermine the integration order of the stock prices, two unit root tests are applied; the Augmented Dickey and Fuller (1979) (ADF) and Kwiatkowski et al. (1992) (KPSS) tests both with a constant and a constant and a trend. The ADF test is setup on the unit root null hypothesis whereas the KPSS test is based on a null hypothesis of stationary time series. The obtained results of both tests are reported in Table 4. The ADF and KPSS tests with both specifications (constant and constant and trend) are applied on the level as well as the difference stock prices. It can be observed from the reported results in Table 4 that the level prices have a unit root. For the ADF test, we cannot reject the null hypothesis of unit root in addition to the results of KPSS test that are significant which states that the null hypothesis of stationarity can be rejected. In contrast, the results of the first difference variables show significant ADF test results which means rejection of the

[5]The test portfolios and factors underlying the paper of Gregory et al. (2013) are found on http://xfi.exeter.ac.uk/researchandpublications/portfoliosandfactors/index.php.

[6]Lee et al. (1995), Jiménez-Rodríguez and Sanchez (2005) and Park and Ratti (2008) use the real price of oil.

null hypothesis of unit root whereas the KPSS test results are insignificant which denote that the stationary null hypothesis cannot be rejected. Therefore, the price index series display a unit root, which show an integration of order one. The first difference series appear stationary as anticipated.

5 Empirical Work and Results

The empirical investigation starts with examining the sensitivity of firms' stock returns to oil price changes using FF-Carhart's (1997) model. In addition, the asymmetry in the reaction of UK firms' stock returns to oil price shocks is examined using two specifications of non-linear measures of oil price changes. Finally, the impact of oil shocks and recessions on the UK firms is explored.

5.1 Sensitivity of stock returns to oil price changes

The exposure of the chosen sample stock returns to oil price changes is scrutinized for each firm severally as an attempt to extend the perception to the link between oil price changes and firms' stock returns. In particular, FF- Carhart's (1997) model is augmented with the change in oil price to examine its effect on each firm's stock returns as stated in equation (1).

Table 5 presents the results of model (1) that are obtained by applying either GARCH(1, 1) for the firms with high ARCH effects in their stock returns, or the Newey and West (1987) estimator for the firms that fail to reject the null hypothesis of no ARCH effects. The firms are reported in groups according to their sector and subsector classifications.

As can be seen from the third column of Table 5, market return coefficients are positive and significant for 20 out of 25 firms. Most of the significant coefficients are less than 1, which indicate that the asset's price is less volatile than the market. The BBA Aviation transportation service company and Easyjet airlines company have market coefficients of greater than 1; offering the possibility of a higher rate of return, but also posing more risk (Sadorsky, 2001).

The fourth column of Table 5 presents the coefficients of the SMB factor which accounts for the spread in returns between small and large-sized firms. The SMB coefficients for most of the firms are positive and significant at the 5% level of significance, except for BP company, with negative and significant SMB coefficient. This

is in line with the findings of Fama and French (1996) and Drew et al. (2003), who detect that small firms tend to have positive slopes on SMB. However, big firms tend to have diminishing positive or negative slopes on SMB, which indicates that they covary more with other large stocks than with small returns stocks.

Only 15 out of 25 firms have a significant positive slope of HML as can be seen from the fifth column of Table 5. Prior research has found that distressed stocks or industries tend to have positive loadings on HML and thus higher future returns while strong firms or industries have negative loadings on HML and lower future returns (Fama and French, 1995). Regarding the momentum variable *Mom*, most of the firms show insignificant response to it.

The main focus of this study is to investigate the relationship between oil price changes and stock returns of individual firms. Column seven of Table 5 demonstrates the oil price returns' coefficients (*Roil*). At first glimpse of the transportation services subsector, it can be noticed that oil price swings have no significant impact on stock returns for most of the firms in this subsector. However, an attentive testing of the obtained results indicates that two firms are having significant exposure to oil price risk. Braemar shipping services and Clarkson firms have a significant positive exposure at 10% and 5% level, respectively. Hence, a rise in the price of oil probably has a significant positive influence on stock returns in these two companies. This may be because; firstly, since these two companies are marine transportation, they are generally more fuel efficient; second, shipping companies gain a major fraction of their earnings by participating in ocean transportation of crude oil and petroleum outputs, so a rise in oil price that is joined with a growth in the overall demand for marine shipping of crude oil may cause an increase in the earnings of these firms. Finally, some companies utilize financial derivatives to hedge against increasing oil prices through the purchase of crude oil futures during periods when the price of oil is on a rising trend that would yield gains for the shipping company. The obtained results are in line with Mohanty and Nandha (2011b) who find a positive and significant oil price coefficient for the US marine transportation sector. Most of the other transportation firms that show insignificant exposure to oil price risk run different types of activities. For example, Sutton Harbour Holdings is the parent of a number of wholly owned subsidiary companies that comprise property and regeneration, marina, fisheries and Plymouth City Airport which was closed in 2011.[7] On top of that, their reports show that they usually hedge 100% of fuel requirements at improving rates to secure budgets.[8] Therefore, oil price fluctuations have insignificant

[7] http://www.suttonharbourholdings.co.uk/about-us/what-we-do

[8] http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aCNsiIDLJKOU

impact. Moreover, the delivery services subsector shows a significant and negative relationship between oil price return and stock returns. For instance, the UK mail group stock returns are affected negatively by the change in oil price. In particular, an increase of 1% in returns of oil price causes a reduction in their stock returns by 0.164%.

The travel and leisure sector includes two of the main subsectors, travel and tourism and airlines. Surprisingly, oil price returns have a weakly significant and negative impact on the stock returns of National Express and Stagecoach Group from the travel and tourism subsector, where an increase of 1% in the price of oil reduces the stock returns of both of them by 0.107% and 0.129%, respectively. These two groups are of the most leading public transport groups who consume 222 and 370 million litres of fuel per year, respectively.[9] However, both groups have hedging contracts to help dilute the effect of jumps in oil prices. On one hand, National Express group announced in mid 2010 that they are fully hedged for 2010 at an average of 39 pence per litre, about 90% hedged for 2011 at 41 pence and 35% hedged for 2012 at 42 pence, which will decrease their exposure to changes in oil price.[10] Two years later, they announce that they are fully hedged for the year 2013 at 48 pence per litre.[11] On the other hand, Stagecoach group is employing a hi-tech echo-driving system, to help decrease the consumption of fuel. Regarding the other airlines sector, the same negative impact is found on its stock returns. However, Easyjet company's stock returns are influenced more significantly by an increase in oil price when compared to Dart group company. Similar to the previously mentioned travel and leisure groups, Dart group's fuel price risk exposure is maintained by forward hedging against any unexpected rise in the price of oil.[12] In one of the recent analysis reports, Easyjet states that although the firm hedges as best it can to prevent or dilute the risk of oil price, fuel cost remains a large risk. The firm's operating income dropped by 47% in the year 2009 as fuel costs rised by 67%.[13]

The last panel of Table 5 displays the results for the oil and gas producers sector. This sector is composed of two subsectors, exploration and production and

[9] http://www.stagecoach.com/media/insight-features/planning-for-a-different-energy-future.aspx
http://www.rttnews.com/1346064/national-express-expects-progress-in-h1-normalized-pre-tax-profit-update.aspx

[10] http://www.nationalexpressgroup.com/media/corporatenews.aspx?newsyear=2010&newsitem=18

[11] http://www.nationalexpressgroup.com/media/corporatenews.aspx?newsyear=2012&newsitem=680

[12] http://www.dartgroup.co.uk/report_and_accounts_2013/business_and_financial_review/

[13] http://analysisreport.morningstar.com/stock/research?t=EZJ&region=gbr&culture=en-US&productcode=MLE

integrated oil and gas where the first subsector includes nine firms and the other includes three firms. Seven out of nine exploration and production firms show a positive and significant exposure to oil risk at the 5% and 1% levels of significance. All the three integrated oil and gas firms are significantly and positively influenced by the changes in oil price. Similar to the results of El-Sharif et al. (2005), who investigate the relationship between the price of crude oil and equity values in the UK oil and gas sector, this study concludes that there is a positive relationship between oil price changes and oil and gas equity returns. Another result worth mentioning is that the oil price return has a greater impact on producers than on integrated firms. This result is consistent with that of Boyer and Filion (2007).

When the FF-Carhart (1997) model is augmented with oil price volatility instead of oil price return as in Model (1), the transportation sector firms show no significant response to it except Sutton Harbour Holdings as can be seen from Table 6. The seventh column that is headed with *Voil* presents the coefficients of oil price volatility. Sutton Harbour Holdings company reacts negatively to the oil price volatility. This result may be imputed to the operating of the regional airline Air Southwest which was subsequently sold at the end of 2010 due to unsustainable losses.[14] Similarly, National Express as a travel and leisure company shows a negative and significant reaction to oil price volatility.

In the oil and gas producers sector, only Fortune Oil company and Sterling Energy company respond significantly and negatively to oil price volatility. Fortune Oil company concentrates mainly on investments and operations in oil and gas supply and infrastructure projects in China whereas Sterling Energy company is interested in potential explorations projects in Africa (Cameroon, Madagascar and Somaliland). At the end of 2013, Sterling Energy company's report stated that one of the risks that the group's business faces is the volatility of oil price that affects its revenues and reserves.[15]

5.2 Asymmetric response of UK firms to oil shocks

5.2.1 Asymmetric specification results

One of the estimation techniques to examine the impact of oil price returns on the firms' equity returns is to investigate its asymmetric effect where increases and decreases in both, oil price returns and its volatility, are included as distinct

[14] http://www.suttonharbourholdings.co.uk/about-us/our-business

[15] http://www.sterlingenergyuk.com/pdf/financial-reports/ReportandFinancialStatements2013.pdf

variables.

Estimation results of the non linear models which are stated in Equations (2) and (4), are presented in Table 7. The second and third columns show the coefficients for increases and decreases in oil price. Tests on the following null hypotheses (a and b) for each firm's stock returns are reported in the fourth and fifth column of the same table.

$$(a) \quad H_{0a} : \beta_{oil}^{+} = \beta_{oil}^{-} = 0 \qquad H_{1a} : \beta_{oil}^{+} \neq \beta_{oil}^{-} \neq 0$$

$$(b) \quad H_{0b} : \beta_{oil}^{+} = \beta_{oil}^{-} \qquad H_{1b} : \beta_{oil}^{+} \neq \beta_{oil}^{-}$$

The first panel shows the results of the firms from the transportation sector. The outcome of the Wald tests indicate that the hypothesis $\beta_{oil}^{+} = \beta_{oil}^{-} = 0$ is rejected only for Clarkson company at the 5% level of significance. This result is in line with that obtained from Table 5, which emphasizes the importance of the effect of oil price changes on the stock returns of this company.

Travel and leisure sector results are presented in the second panel. National Express company (one of the travel and tourism companies), reacts to the changes in oil price asymmetrically. This can be deduced from the significant results of Wald tests which suggest that the null hypotheses $\beta_{oil}^{+} = \beta_{oil}^{-} = 0$ and $\beta_{oil}^{+} = \beta_{oil}^{-}$ are rejected at 1% level. These findings might give confirmation for the relationship between oil price changes and the group's stock returns. The hikes in oil price have a significant negative impact, whereas a fall in the price of oil has a significant positive effect on the returns of National Express group. When comparing this result with the weakly significant impact of oil price changes that was obtained in Table 5, it can be argued that the group's stock returns react differently and significantly to the increases and decreases in oil price. Similarly, both of the null hypotheses are rejected at 5% level for the Stagecoach group. The obtained results provide evidence that the stock returns of this firm respond negatively to increases in oil price but show no response to oil price dropping. One more rejection for the two hypotheses is for the impact of the hikes and drops in oil price on the Dart group's stock returns. Drops in oil price affect it negatively but no significant impact of the rises in oil price. The negative impact of the drop in oil price might be attributed to the hedging strategy that they imply to protect from high energy costs, but also might deprive them from enjoying lower costs when the crude price falls.

The oil and gas producers sector results demonstrate that the first hypothesis ($\beta_{oil}^{+} = \beta_{oil}^{-} = 0$) is rejected for 10 out of 12 firms, usually at the 1% level. These outcomes assert the findings of Table 5, which show the important role for oil price changes in

determining the stock price returns of this sector's firms. The BP integrated oil and gas company is the one and only exception which shows a rejection for the second hypothesis ($\beta^{+}_{oil} = \beta^{-}_{oil}$), as well. This result leads to an asymmetric reaction of the BP stock returns to a change in oil price, where it respond positively to an increase in oil price, but no significant reaction to drops in oil price.

5.2.2 Scaled specification results

The results of the second scaled specification are reported in the sixth column and beyond of Table 7. The hypotheses $\beta^{+}_{Voil} = \beta^{-}_{Voil} = 0$ and $\beta^{+}_{Voil}\ \beta =^{-}_{Voil}$ are rejected for Sutton Harbour Holdings company which asserts the result obtained in Table 6. The stock returns react negatively and significantly to decreases in oil price volatility but no response to the increases.
The hypothesis $\beta^{+}_{Voil} = \beta^{-}_{Voil} = 0$ is rejected for National Express, Fortune Oil and Sterling Energy companies, which emphasizes the prominence of oil price shocks. These results are in line with that stated in Table 6. Although the results of Table 6 do not show any significant response to oil price volatility from Premier Oil, Tullow Oil and BG Group companies, however, the results that are displayed in Table 7 illustrate that the stock returns of the previously mentioned companies react positively to increases in oil price volatility and do not respond to decreases in its volatility. This outcome is confirmed by the rejection of both hypotheses; $\beta^{+}_{Voil} = \beta^{-}_{Voil} = 0$ and $\beta^{+}_{Voil} = \beta^{-}_{Voil}$, for these firms.[16]

5.3 Reactivity of Stock returns to oil price shocks during recessions

In this section, the effect of the global recession on the stock returns of the sectors' firms is investigated.[17] In order to examine this effect, a dummy variable (D_1) is generated that equals one in the period from December 2007 to June 2009 to show the period of the global recession following Mohanty et al. (2014).[18] This dummy is

[16]Model (1) is augmented with both oil price change and oil price volatility, but no significant change in the coefficients obtained. Similarly, the asymmetric effect is examined using both specifications, but no noticeable change in coefficients nor in hypotheses tests. Therefore, these results are not reported here.

[17]Mohanty et al. (2014) scrutinize the impact of the change in oil prices on the travel and leisure sector returns over three different US recessions

[18]http://www.huffingtonpost.com/2009/07/16/imf-predicts-end-of-globa_n_236690.html

interacted with the oil price return ($Roil_t$). The augmented model is presented in Equation (5) and the results are reported in Table 8.

In general, the results of the transportation industry stock returns show insignificant reaction to the high oil prices in recession time. However, Ocean Wilsons Holdings' stock returns are affected positively during the recession period as can be seen from the fourth column of Table 8. Ocean Wilsons Holdings firms is a marine transportation that provides support services to the oil and gas industry. In addition, this type of transportation uses financial derivatives to hedge against increases in oil price.[19]

Travel and leisure firms, specifically the travel and tourism subsector firms present a significant positive response to the change in oil prices over the time of recession. This can be observed from the results of Go-ahead group, National express and Stagecoach group. For example, National express overall response to the change in oil price is positive ($-0.144 + 0.441 = 0.297\%$). The positive response can be attributed to the hedging strategy that these firms follow to decrease the impact of the increase in oil prices.

For the oil and gas producers sector, only two firms, namely BP and Royal dutch shell, from the integrated oil and gas subsector show significant reaction to the oil price changes while recession. Unexpectedly, their response appears to be negative.[20] This may be explained through the role of this type of firm. Integrated companies split their different processes into two streams: upstream, which involve all exploration and production efforts; and downstream, that is limited to the improvement and marketing activities. During the periods of oil price increases, these companies may have lower profit margins due to having greater downstream than upstream capability.

6 Conclusions

This study empirically investigates the relationship between oil price shocks and the equity returns of 25 UK firms. Contrary to other empirical studies that investigate the oil price exposure of stock returns at the aggregate and sectoral levels (and in most of the cases using the US data), this study explores this relationship at the firm level. Specifically, transportation, travel and leisure and oil and gas sectors'

https://www.imf.org/external/pubs/ft/fandd/2009/03/basics.htm
https://www.businesscycle.com/pdf/trackrecord/0808ICO_Overall.pdf

[19] http://www.oceanwilsons.bm/news-item?item=971107138033562

[20] Tsai (2015) find that US stock returns of some energy-intensive manufacturing industries respond more positively to oil price shocks compared with less energy-intensive manufacturing industries

firms over the period from 1998m01 to 2012m12. The sample is chosen on the basis of the availability of long historical data and as they form two different sides of the oil market, consumers and producers of crude oil. The oil price exposure of the firms' returns is examined using FF-Carhart (1997) four factor asset pricing model that is augmented with oil price risk using two measures, oil price change and oil price volatility.

Contrary to what was expected, most of the stock returns of the transportation sector's firms show insignificant exposure to oil price risk, except two firms from the transportation services subsector. These two firms are marine transportation, which are fuel efficient, usually participate in ocean transportation of crude oil and petroleum outputs, and hedge against the rise in oil price . Therefore, the exposure of this type of company to the oil price is positive and significant. Similarly, hedging contracts help dilute the negative effect of jumps in oil prices on the returns of travel and tourism and airlines subsectors firms. Comparably, most of the oil and gas firms respond positively to the change in oil price. However, oil price returns have a greater impact on exploration and production firms than on integrated firms.

In addition, the asymmetric response of the firms' returns is examined using two different measures, increases and decreases in oil price, and hikes and drops in oil price volatility. It has been found that some firms show asymmetric response to theses measures, including travel and tourism, airlines and integrated oil and gas firms.

The obtained results might be of interest to researchers, regulators and investors. Investors who wish to invest in oil price-sensitive stocks, should choose oil and gas and marine transportation stocks when the prices are high and choose travel and tourism and airlines stocks when the oil prices are expected to drop. Moreover, hedging minimizes the responsiveness of the firms' stock returns to the changes in oil prices. As the firms' returns have different distinct sensitivities to oil price changes, diversifying between stocks in the investors' portfolios, particularly holding some assets with affirmative response to oil price shocks, may help reducing the impact of the change in oil prices. Investors should consider any forthcoming rises or drops in oil price and try to stabilize their portfolios accordingly.

Table 1: **ARCH-LM test for residuals of firm's stock returns**

Company	ARCH-LM statistic (NR^2)	Prob. Chi-square(4)
Transportation		
Transportation Services		
BBA AVIATION	10.757	0.029
BRAEMAR SHIPPING SVS.	1.101	0.894
CLARKSON	10.033	0.039
FISHER(JAMES) & SONS	12.869	0.012
OCEAN WILSONS HOLDINGS	1.117	0.892
SUTTON HARBOUR HDG.	10.037	0.039
Delivery Services		
UK MAIL GROUP	6.819	0.009
Travel & Liesure		
Travel & Tourism		
FIRST GROUP	6.632	0.157
GO-AHEAD GROUP	0.506	0.973
NATIONAL EXPRESS	26.66	0.000
STAGECOACH GROUP	16.233	0.003
Airlines		
DART GROUP	44.401	0.000
EASYJET	5.332	0.255
Oil & Gas Producers		
Exploration & Production		
AMERISUR RESOURCES	3.101	0.541
CAIRN ENERGY	9.406	0.052
FORTUNE OIL	4.579	0.333
JKX OIL & GAS	27.397	0.000
NORTHERN PETROLEUM	13.93	0.008
PREMIER OIL	0.101	0.751
SOCO INTERNATIONAL	13.453	0.009
STERLING ENERGY	1.044	0.903
TULLOW OIL	12.198	0.016
Integrated Oil & Gas		
BG GROUP	1.373	0.849
BP	5.275	0.022
ROYAL DUTCH SHELL B	3.937	0.415

Table 2: **Firms Returns Descriptive Statistics**

Firm	**Mean**	**Std. Dev.**	**Min**	**Max**	**Skewness**	**p-value**	**Kurtosis**	**p-value**
Transportation								
Transportation Services								
BBA AVIATION	-0.006	0.108	-0.332	0.257	-0.390	0.032	3.393	0.224
BRAEMAR SHIPPING SVS.	-0.001	0.099	-0.464	0.357	-0.419	0.021	6.242	0.000
CLARKSON	0.010	0.109	-0.371	0.303	-0.374	0.039	4.644	0.002
FISHER(JAMES) & SONS	0.007	0.092	-0.397	0.325	-0.399	0.028	5.641	0.0001
OCEAN WILSONS HOLDINGS	0.009	0.089	-0.478	0.190	-0.770	0.0001	6.854	0.000
SUTTON HARBOUR HDG.	-0.004	0.095	-0.332	0.303	-0.288	0.107	5.431	0.0001
Delivery Services								
UK MAIL GROUP	-0.006	0.124	-0.783	0.252	-2.126	0.000	12.705	0.000
Travel & Liesure								
Travel & Tourism								
FIRST GROUP	-0.003	0.097	-0.417	0.317	-0.343	0.057	5.203	0.0003
GO-AHEAD GROUP	0.002	0.091	-0.379	0.255	-0.836	0.000	5.488	0.0001
NATIONAL EXPRESS	-0.006	0.108	-0.455	0.456	-0.691	0.0003	7.469	0.000
STAGECOACH GROUP	0.0005	0.140	-0.548	0.674	0.000	0.011	1.800	0.000

Table 2 – Continued

Firm	Mean	Std. Dev.	Min	Max	Skewness	p-value	Kurtosis	p-value
Airlines								
DART GROUP	0.003	0.131	-0.529	0.487	-0.055	0.754	6.012	0.000
EASYJET	0.003	0.125	-0.500	0.356	-0.856	0.0001	4.813	0.003
Oil & Gas Producers								
Exploration & Production								
AMERISUR RESOURCES	0.008	0.199	-0.816	0.677	-0.053	0.762	4.434	0.005
CAIRN ENERGY	0.006	0.133	-0.522	0.385	-0.530	0.004	4.811	0.001
FORTUNE OIL	-0.004	0.154	-0.643	0.545	0.221	0.214	5.326	0.0002
JKX OIL & GAS	-0.0005	0.152	-0.624	0.470	-0.359	0.047	5.097	0.0004
NORTHERN PETROLEUM	-0.008	0.214	-0.626	1.151	0.745	0.0001	7.874	0.000
PREMIER OIL	0.003	0.118	-0.387	0.313	-0.415	0.023	4.225	0.010
SOCO INTERNATIONAL	0.004	0.141	-0.796	0.370	-1.046	0.000	8.349	0.000
STERLING ENERGY	-0.027	0.166	-0.765	0.412	-0.868	0.000	6.559	0.000
TULLOW OIL	0.009	0.134	-0.538	0.366	-0.784	0.0001	5.848	0.000
Integrated Oil & Gas								
BG GROUP	0.006	0.079	-0.444	0.186	-1.221	0.000	8.742	0.000
BP	-0.003	0.076	-0.382	0.212	-0.760	0.0001	5.728	0.0001
ROYAL DUTCH SHELL B	-0.001	0.072	-0.170	0.274	0.338	0.060	3.783	0.052

Table 3: **Descriptive statistics for the other factors**

Variable	Mean	Std. Dev.	Min	Max	Skewness	p-value	Kurtosis	p-value	observations
RM	0.002	0.043	-0.136	0.099	-0.669	0.0005	3.601	0.104	180
SMB	0.002	0.036	-0.114	0.165	0.038	0.831	5.400	0.0002	180
HML	0.003	0.040	-0.185	0.122	-0.519	0.005	7.923	0.000	180
Mom	0.007	0.055	-0.274	0.138	-1.129	0.000	7.109	0.000	180
Roil	0.004	0.038	-0.144	0.089	-0.822	0.000	4.673	0.002	180

Notes: This Table presents the descriptive statistics of all explanatory variables. RM is the monthly market portfolio excess return, SMB is the difference in monthly return between a small cap portfolio and a large cap portfolio, HML is the difference in monthly return between a portfolio of high book-to-market stocks and one of low book-to-market stocks, Mom is the difference between the equal weighted average of the highest performing firms and the equal weighted average of the lowest performing firms and Roil is the monthly return on the oil price.

Table 4: **Unit root tests**

	Levels				**First difference**			
	ADF		**KPSS**		**ADF**		**KPSS**	
Firm	*Const.*	*Const.* + *Trend*	*Const.*	*Const.* + *Trend*	*Const.*	*Const.* + *Trend*	*Const.*	*Const.* + *Trend*
Transportation								
Transportation Services								
BBA AVIATION	-1.861	-2.304	0.834***	0.0795	-13.983***	-13.953***	0.074	0.052
BRAEMAR SHIPPING SVS.	-1.557	-2.474	0.962***	0.122*	-12.629***	-12.593***	0.082	0.080
CLARKSON	-1.061	-1.680	1.210***	0.241***	-11.626***	-11.602***	0.097	0.070
FISHER(JAMES) & SONS	-0.333	-2.275	1.220***	0.221***	-12.758***	-12.753***	0.144	0.138
OCEAN WILSONS HOLDINGS	-0.389	-1.182	1.280***	0.156**	-12.399***	-12.367***	0.165	0.155**
SUTTON HARBOUR HDG.	-1.053	-0.861	0.317	0.270***	-13.236***	-13.307***	0.251	0.108
Delivery Services								
UK MAIL GROUP	-2.661	-2.740	0.371*	0.130*	-11.357***	-11.332***	0.062	0.059
Travel & Liesure								
Travel & Tourism								
FIRST GROUP	-1.918	-1.675	0.297	0.163**	-12.868***	-12.923***	0.179	0.064
GO-AHEAD GROUP	-1.832	-1.766	0.866***	0.200**	-12.420***	-12.425***	0.116	0.056
NATIONAL EXPRESS	-1.578	-2.152	0.455*	0.124*	-11.921***	-11.899***	0.079	0.046
STAGECOACH GROUP	-1.278	-1.887	0.515**	0.202**	-12.651***	-12.683***	0.152	0.056
Airlines								
DART GROUP	-1.805	-1.880	0.092	0.052	-12.038***	-12.010***	0.055	0.051

Table 4 – Continued

	Levels				First difference			
	ADF		KPSS		ADF		KPSS	
Firm	*Const.*	*Const.* + *Trend*	*Const.*	*Const.* + *Trend*	*Const.*	*Const.* + *Trend*	*Const.*	*Const.* + *Trend*
EASYJET	-1.572	-2.083	0.312	0.074	-10.643***	-10.671***	0.116	0.059
Oil & Gas Producers								
Exploration & Production								
AMERISUR RESOURCES	-0.904	-1.745	0.616**	0.185**	-12.850***	-12.888***	0.169	0.041
CAIRN ENERGY	-0.623	-2.352	1.250***	0.171**	-12.247***	-12.216***	0.144	0.143
FORTUNE OIL	-1.643	-3.316	0.760***	0.140*	-14.443***	-14.586***	0.275	0.113
JKX OIL & GAS	-0.815	-0.556	1.050***	0.220***	-11.800	-11.788***	0.219	0.195**
NORTHERN PETROLEUM	-1.643	-3.095	0.957***	0.168**	-14.948***	-14.939***	0.218	0.188**
PREMIER OIL	-0.535	-3.589**	1.240***	0.129*	-12.357***	-12.377***	0.246	0.188**
SOCO INTERNATIONAL	-0.571	-2.617	1.180***	0.181**	-11.823***	-11.817***	0.139	0.131
STERLING ENERGY	-1.537	-1.795	0.803***	0.200**	-12.071***	-12.046***	0.118	0.120
TULLOW OIL	-0.262	-3.467	1.290***	0.225***	-16.528***	-16.595***	0.278	0.168
Integrated Oil & Gas								
BG GROUP	-0.971	-2.209	1.320***	0.180**	-15.617***	-15.584***	0.147	0.130
BP	-3.496***	-3.627	0.154	0.122*	-14.775***	-14.777***	0.145	0.053
ROYAL DUTCH SHELL B	-2.747*	-3.342*	0.535**	0.092	-15.057***	-15.015***	0.061	0.047

Notes: This Table presents unit root tests results for the log of price index (level) and difference log of price index series for 25 firms from the UK transportation, travel and leisure, and oil and gas producers sectors. ADF presents Augmented Dickey and Fuller (1979) and KPSS presents Kwiatkowski et al. (1992) tests. ***, **, and * indicate a statistical significance of 1%, 5% and 10%, respectively.

Table 5: **Response of UK firms to changes in oil price**

Firm	**Constant**	**RM**	**SMB**	**HML**	**Mom**	**Roil**	**ARCH**	**GARCH**	R^2
				Transportation					
Transportation Services									
BBA AVIATION	-0.010	1.103	1.095	0.286	-0.155	-0.038	0.234	0.637	
	(0.004)**	(0.128)***	(0.147)***	(0.138)**	(0.106)	(0.057)	(0.128)	(0.185)***	
BRAEMAR SHIPPING SVS.	-0.006	0.513	0.412	0.334	0.219	0.143			0.1038
	(0.007)	(0.166)***	(0.263)	(0.185)*	(0.175)	(0.086)*			
CLARKSON	0.007	0.681	0.531	0.464	0.161	0.218	0.130	0.742	
	(0.008)	(0.194)***	(0.218)**	(0.244)*	(0.172)	(0.089)**	(0.078)*	(0.156)***	
FISHER(JAMES) & SONS	0.008	0.310	0.732	0.392	0.038	0.004	0.366	0.438	
	(0.006)	(0.128)**	(0.168)***	(0.217)*	(0.139)	(0.065)	(0.107)***	(0.109)***	
OCEAN WILSONS HOLDINGS	0.006	0.277	0.940	0.292	0.041	-0.011			0.1800
	(0.006)	(0.159)*	(0.234)***	(0.189)	(0.136)	(0.0178)			
SUTTON HARBOUR HDG.	-0.008	0.410	0.909	0.519	0.243	0.020	0.356	0.406	
	(0.006)	(0.132)***	(0.180)***	(0.182)***	(0.138)*	(0.070)	(0.162)**	(0.205)**	
Delivery Services									
UK MAIL GROUP	0.002	0.535	0.498	-0.186	0.140	-0.164	0.827		
	(0.009)	(0.163)***	(0.197)**	0.246)	(0.204)	(0.083)**	(0.0205)***		

Table 5 – Continued

Firm	Constant	RM	SMB	HML	Mom	Roil	ARCH	GARCH	R^2
				Travel & Liesure					
Travel & Tourism									
FIRST GROUP	-0.008	0.224	0.466	0.619	0.088	0.108			0.1043
	(0.007)	(0.150)	(0.158)***	(0.233)***	(0.133)	(0.087)			
GO-AHEAD GROUP	-0.004	0.135	0.846	0.524	0.243	0.081			0.1420
	(0.007)	(0.172)	(0.161)***	(0.236)**	(0.132)*	(0.109)			
NATIONAL EXPRESS	0.004	0.294	0.734	0.325	-0.008	-0.107	0.527	0.445	
	(0.005)	(0.128)**	(0.149)***	(0.153)**	(0.114)	(0.060)*	(0.206)***	(0.115)***	
STAGECOACH GROUP	0.001	0.748	0.821	0.157	0.252	-0.129	0.284	0.696	
	(0.006)	(0.146)***	(0.189)***	(0.205)	(0.162)	(0.072)*	(0.143)**	(0.132)***	
Airlines									
DART GROUP	0.004	0.494	0.933	0.142	0.0005	-0.171	0.189	0.704	
	(0.009)	(0.171)***	(0.264)***	(0.279)	(0.222)	(0.096)*	(0.097)**	(0.142)***	
EASYJET	-0.001	1.117	1.209	-0.286	0.240	-0.242			0.2556
	(0.011)	(0.312)***	(0.382)***	(0.347)	(0.224)	(0.123)**			
				Oil & Gas Producers					
Exploration & Production									
AMERISUR RESOURCES	0.001	0.958	0.959	0.113	0.352	0.140			0.0859
	(0.014)	(0.356)***	(0.420)**	(0.339)	(0.343)	(0.178)			
CAIRN ENERGY	-0.011	0.718	0.924	0.648	0.397	0.427	0.172	0.769	
	(0.009)	(0.215)***	(0.218)***	(0.245)***	(0.205)**	(0.088)***	(0.068)**	(0.095)***	

Table 5 – Continued

Firm	**Constant**	**RM**	**SMB**	**HML**	**Mom**	**Roil**	**ARCH**	**GARCH**	R^2
FORTUNE OIL	-0.015	0.513	1.028	0.833	0.492	0.403			0.1651
	(0.010)	(0.225)**	(0.340)***	(0.352)**	(0.290)*	(0.132)***			
JKX OIL & GAS	-0.007	0.029	0.922	0.413	0.363	0.321	0.460		
	(0.011)	(0.236)	(0.294)***	(0.335)	(0.208)*	(0.131)**	(0.211)**		
NORTHERN PETROLEUM	-0.018	0.490	1.508	0.560	0.204	0.423	0.630		
	(0.012)	(0.340)	(0.459)***	(0.315)*	(0.258)	(0.131)***	(0.149)***		
PREMIER OIL	-0.007	0.537	0.986	0.970	0.227	0.322			0.2813
	(0.008)	(0.189)***	(0.209)***	(0.220)***	(0.183)	(0.117)***			
SOCO INTERNATIONAL	0.011	0.435	0.433	0.052	0.030	0.153	0.232	0.587	
	(0.011)	(0.245)*	(0.304)	(0.267)	(0.172)	(0.132)	(0.104)**	(0.175)***	
STERLING ENERGY	-0.030	0.418	0.625	0.200	-0.345	0.318			0.1021
	(0.012)**	(0.260)	(0.272)**	(0.441)	(0.328)	(0.149)**			
TULLOW OIL	0.001	0.746	0.366	0.374	0.678	0.337	0.361	0.461	
	(0.006)	(0.158)***	(0.234)	(0.180)**	(0.143)***	(0.083)***	(0.129)***	(0.157)***	
Integrated Oil & Gas									
BG GROUP	0.002	0.510	0.005	0.312	0.123	0.205			0.1457
	(0.005)	(0.131)***	(0.197)	(0.140)**	(0.129)	(0.071)***			
BP	-0.005	0.773	-0.298	0.226	0.138	0.230	0.299		
	(0.003)*	(0.111)***	(0.131)**	(0.104)**	(0.083)*	(0.045)***	(0.072)***		

Table 5 – Continued

Firm	Constant	RM	SMB	HML	Mom	Roil	ARCH	GARCH	R^2
ROYAL DUTCH SHELL B	-0.005	0.718	-0.072	0.169	0.163	0.226			0.2494
	(0.004)	(0.101)***	(0.152)	(0.108)	(0.132)	(0.095)**			

Notes: This Table presents the estimation results of Equation 1 for 25 firms from the UK transportation, travel and leisure, and oil and gas producers sectors. The figures that are stated in parentheses are standard errors that are asymptotically robust to the existence of heteroscedasticity and serial autocorrelation. ***, **, and * indicate a statistical significance of 1%, 5% and 10%, respectively.

Table 6: **Oil price volatility impact on UK companies**

Firm	Constant	RM	SMB	HML	Mom	Voil	ARCH	GARCH	R^2
Transportation									
Transportation Services									
BBA AVIATION	-0.018	1.110	1.097	0.309	-0.144	0.111	0.268	0.581	
	(0.007)**	(0.124)***	(0.139)***	(0.133)**	(0.104)	(0.081)	(0.144)*	(0.196)***	
BRAEMAR SHIPPING SVS.	0.010	0.475	0.460	0.280	0.177	-0.229			0.1016
	(0.012)	(0.169)***	(0.261)*	(0.181)	(0.163)	(0.150)			
CLARKSON	0.014	0.797	0.485	0.746	0.223	-0.024	0.229	0.581	
	(0.016)	(0.212)***	(0.233)**	(0.22)***	(0.186)	(0.173)	(0.121)*	(0.211)***	
FISHER(JAMES) & SONS	0.019	0.271	0.699	0.365	0.020	-0.183	0.384	0.433	
	(0.010)**	(0.128)**	(0.163)***	(0.208)*	(0.131)	(0.125)	(0.108)***	(0.103)***	

Table 6 – Continued

Firm	**Constant**	**RM**	**SMB**	**HML**	**Mom**	**Voil**	**ARCH**	**GARCH**	R^2
OCEAN WILSONS HOLDINGS	0.012	0.254	0.930	0.266	0.013	-0.097			0.1841
	(0.010)	(0.150)*	(0.221)***	(0.189)	(0.132)	(0.138)			
SUTTON HARBOUR HDG.	0.008	0.412	0.887	0.465	0.218	-0.230	0.425	0.387	
	(0.009)	(0.126)***	(0.177)***	(0.168)***	(0.138)	(0.117)**	(0.173)**	(0.177)**	
Delivery Services									
UK MAIL GROUP	-0.004	0.505	0.490	-0.199	0.095	0.051	0.760		
	(0.012)	(0.164)***	(0.196)**	(0.242)	(0.201)	(0.122)	(0.192)***		
Travel & Liesure									
Travel & Tourism									
FIRST GROUP	0.008	0.221	0.472	0.574	0.082	-0.222			0.1058
	((0.014)	(0.146)	(0.149)***	(0.228)**	(0.146)	(0.184)			
GO-AHEAD GROUP	0.0004	0.131	0.874	0.512	0.241	-0.061			0.1378
	(0.012)	(0.171)	(0.154)***	(0.232)**	(0.134)*	(0.174)			
NATIONAL EXPRESS	0.019	0.474	0.593	0.248	-0.117	-0.356	0.985		
	(0.007)***	(0.109)***	(0.118)***	(0.118)**	(0.128)	(0.048)***	(0.218)***		
STAGECOACH GROUP	0.018	0.531	0.805	0.128	0.174	-0.257	0.273	0.706	
	(0.011)	(0.164)***	(0.210)***	(0.226)	(0.175)	(0.164)	(0.122)**	(0.117)***	
Airlines									
DART GROUP	-0.021	0.516	0.831	0.202	0.077	0.377	0.190	0.709	
	(0.018)	(0.165)***	(0.259)***	(0.288	(0.231)	(0.250)	(0.094)**	(0.136)***	

Table 6 – Continued

Firm	**Constant**	**RM**	**SMB**	**HML**	**Mom**	**Voil**	**ARCH**	**GARCH**	R^2
EASYJET	-0.006	1.093	1.109	-0.225	0.200	0.077			0.2338
	(0.016)	(0.327)***	(0.364)***	(0.360)	(0.254)	(0.146)			
				Oil & Gas Producers					
Exploration & Production									
AMERISUR RESOURCES	0.020	0.869	1.030	0.038	0.256	-0.276			0.0849
	(0.024)	(0.346)**	(0.421)**	(0.351)	(0.360)	(0.217)			
CAIRN ENERGY	0.004	0.598	1.153	0.607	0.385	-0.204	0.120	0.798	
	(0.018)	(0.219)***	(0.216)***	(0.275)**	(0.213)*	(0.179)	(0.067)*	(0.125)***	
FORTUNE OIL	0.017	0.430	1.186	0.728	0.408	-0.446			0.1385
	(0.016)	(0.222)*	(0.338)***	(0.377)*	(0.297)	(0.192)**			
JKX OIL & GAS	-0.005	0.092	1.144	0.393	0.388	-0.144	0.344		
	(0.028)	(0.261)	(0.291)***	(0.343)	(0.231)*	(0.264)	(0.148)**		
NORTHERN PETROLEUM	0.006	0.404	1.719	0.409	0.068	-0.250	0.606		
	(0.022)	(0.334)	(0.463)***	(0.336)	(0.267)	(0.253)	(0.135)***		
PREMIER OIL	-0.010	0.551	1.149	0.993	0.257	0.066			0.2342
	(0.014)	(0.210)***	(0.237)***	(0.241)***	(0.188)	(0.184)			
SOCO INTERNATIONAL	0.013	0.432	0.477	0.018	0.018	-0.033	0.235	0.571	
	(0.018)	(0.247)*	(0.302)	(0.276)	(0.176)	(0.223)	(0.109)**	(0.189)***	
STERLING ENERGY	0.024	0.339	0.672	0.031	-0.440	-0.753			0.1235
	(0.018)	(0.249)	(0.261)**	(0.434)	(0.298)	(0.204)***			

Table 6 – Continued

Firm	**Constant**	**RM**	**SMB**	**HML**	**Mom**	**Voil**	**ARCH**	**GARCH**	R^2
TULLOW OIL	0.008	0.738	0.604	0.418	0.645	-0.136	0.366	0.459	
	(0.011)	(0.160)***	(0.261)**	(0.190)**	(0.155)***	(0.137)	(140)***	(0.144)***	
Integrated Oil & Gas									
BG GROUP	0.002	0.543	0.088	0.328	0.167	0.022			0.1052
	(0.010)	(0.129)***	(0.215)	(0.139)**	(0.139)	(0.146)			
BP	-0.008	0.784	-0.210	0.245	0.172	0.063	0.298		
	(0.006)	(0.122)***	(0.140)	(0.118)**	(0.089)**	(0.079)	(0.078)***		
ROYAL DUTCH SHELL B	-0.004	0.695	0.054	0.166	0.148	-0.008			0.1735
	(0.008)	(0.114)***	(0.165)	(0.119)	(0.129)	(0.100)			

Notes: This Table presents the estimation results of Equation 1 (with the change in oil price volatility as a measure for oil price risk) for 25 firms from the UK transportation, travel and leisure, and oil and gas producers sectors. The figures that are stated in parentheses are standard errors that are asymptotically robust to the existence of heteroscedasticity and serial autocorrelation. ***, **, and * indicate a statistical significance of 1%, 5% and 10%, respectively.

Table 7: **Asymmetric response of UK firms to oil shocks**

	Asymmetric Specification (Model 2)				**Scaled Specification (Model 4)**			
Firm	β^+_{oil}	β^-_{oil}	$\beta^+_{oil} = \beta^-_{oil} = 0$	$\beta^+_{oil} = \beta^-_{oil}$	β^+_{Voil}	β^-_{Voil}	$\beta^+_{Voil} = \beta^-_{Voil} = 0$	$\beta^+_{Voil} = \beta^-_{Voil}$
				Transportation				
Transportation Services								
BBA AVIATION	-0.056	-0.023	0.47	0.03	0.006	0.117	2.32	0.49
	(0.121)	(0.114)	(0.793)	(0.175)	(0.180)	(0.086)	(0.314)	(0.485)
BRAEMAR SHIPPING SVS.	0.193	0.100	1.76	0.09	-0.157	-0.241	0.58	0.11
	(0.154)	(0.192)	(0.175)	(0.761)	(0.317)	(0.227)	(0.563)	(0744)
CLARKSON	0.164	0.284	**8.56**	0.28	0.060	-0.189	0.95	1.43
	(0.145)	(0.133)**	**(0.014)**	(0.599)	(0.277)	(0.218)	(0.388)	(0.233)
FISHER(JAMES) & SONS	0.079	-0.065	0.49	0.49	-0.195	-0.181	2.14	0.01
	(0.132)	(0.112)	(0.782)	(0.484)	(0.196)	(0.125)	0.344	(0.931)
OCEAN WILSONS HOLDINGS	-0.077	0.047	0.15	0.27	-0.074	-0.101	0.27	0.02
	(0.143)	(0.140)	(0.859)	(0.605)	(0.188)	(0.138)	(0.763)	(0.877)
SUTTON HARBOUR HDG.	-0.042	0.082	0.47	0.34	0.071	-0.205	**5.68**	**2.92**
	(0.132)	(0.120)	(0.790)	(0.558)	(0.180)	(0.107)*	**(0.058)**	**(0.088)**
Delivery Services								
UK MAIL GROUP	-0.336	0.072	3.62	**3.31**	-0.116	0.093	1.74	1.18
	(0.177)**	(0.083)	(0.164)	**(0.069)**	(0.235)	(0.130)	(0.418)	(0.277)

Table 7 – Continued

Firm	Asymmetric Specification (Model 2)				Scaled Specification (Model 4)			
	β^+_{oil}	β^-_{oil}	$\beta^+_{oil} = \beta^-_{oil} = 0$	$\beta^+_{oil} = \beta^-_{oil}$	β^+_{Voil}	β^-_{Voil}	$\beta^+_{Voil} = \beta^-_{Voil} = 0$	$\beta^+_{Voil} = \beta^-_{Voil}$
Travel & Liesure								
Travel & Tourism								
FIRST GROUP	0.057	0.154	1.49	0.17	-0.158	-0.233	0.90	0.16
	(0.183)	(0.100)	(0.228)	(0.677)	(0.262)	(0.182)	(0.409)	(0.691)
GO-AHEAD GROUP	-0.006	0.156	0.32	0.36	0.050	-0.079	0.34	0.65
	(0.125)	(0.204)	(0.728)	(0.551)	(0.188)	(0.174)	(0.714)	(0.422)
NATIONAL EXPRESS	-0.451	0.535	**5.56**	**10.56**	-0.587	-0.614	**31.109**	0.023
	(0.196)**	(0.176)***	**(0.005)**	**(0.001)**	(0.185)***	(0.114)***	**(0.000)**	(0.880)
STAGECOACH GROUP	-0.349	0.079	**8.437**	**4.688**	-0.289	-0.101	1.709	1.034
	(0.121)***	(0.122)	**(0.015)**	**(0.030)**	(0.224)	(0.172)	(0.426)	(0.309)
Airlines								
DART GROUP	0.131	-0.456	**5.40**	**3.44**	0.261	0.413	2.50	0.38
	(0.172)	(0.198)**	**(0.067)**	**(0.064)**	(0.306)	(0.263)	(0.286)	(0.536)
EASYJET	-0.460	-0.058	**4.51**	1.56	-0.087	0.100	0.70	0.88
	(0.170)***	(0.219)	**(0.013)**	(0.213)	(0.254)	(0.149)	(0.498)	(0.350)
Oil & Gas Producers								
Exploration & Production								
AMERISUR RESOURCES	-0.134	0.381	0.84	0.86	-0.769	-0.196	2.21	2.47
	(0.352)	(0.298)	(0.432)	(0.355)	(0.366)**	(0.241)	(0.113)	(0.118)
CAIRN ENERGY	0.369	0.526	**31.01**	0.27	0.052	-.223	2.37	0.90
	(0.210)*	(0.138)***	**(0.000)**	(0.602)	(0.325)	(0.174)	(0.307)	0.343)

Table 7 – Continued

	Asymmetric Specification (Model 2)				Scaled Specification (Model 4)			
Firm	β^+_{oil}	β^-_{oil}	$\beta^+_{oil} = \beta^-_{oil} = 0$	$\beta^+_{oil} = \beta^-_{oil}$	β^+_{Voil}	β^-_{Voil}	$\beta^+_{Voil} = \beta^-_{Voil} = 0$	$\beta^+_{Voil} = \beta^-_{Voil}$
FORTUNE OIL	0.356	0.444	**4.99**	0.04	-0.121	-0.499	**2.67**	2.10
	(0.291)	(0.214)**	**(0.008)**	(0.838)	(0.243)	(0.219)**	**(0.072)**	(0.149)
JKX OIL & GAS	0.511	0.159	**6.58**	0.71	0.141	-0.217	1.80	0.98
	(0.264)**	(0.230)	**(0.037)**	(0.399)	(0.481)	(0.277)	(0.406)	(0.322)
NORTHERN PETROLEUM	0.523	0.320	**12.01**	0.34	-0.097	-0.286	1.11	0.28
	(0.181)***	(0.261)	**(0.003)**	(0.561)	(0.345)	(0.272)	(0.573)	(0.596)
PREMIER OIL	0.517	0.150	**6.96**	1.02	0.391	0.013	**2.59**	**3.66**
	(0.001)***	(0.232)	**(0.001)**	(0.313)	(0.193)**	(0.196)	**(0.078)**	**(0.057)**
SOCO INTERNATIONAL	0.188	0.122	1.40	0.03	-0.072	-0.020	0.05	0.03
	(0.122)	(0.239)	(0.498)	(0.874)	(0.330)	(0.226)	(0.977)	(0.865)
STERLING ENERGY	0.176	0.442	**3.40**	0.47	-0.543	-0.787	**6.41**	0.74
	(0.291)	(0.193)**	**(0.000)**	(0.493)	(0.271)**	(0.225)***	**(0.002)**	(0.391)
TULLOW OIL	0.254	0.394	**17.81**	0.22	0.553	-0.073	**6.07**	**5.83**
	(0.210)	(0.132)***	**(0.000)**	(0.636)	(0.291)*	(0.137)	**(0.048)**	**(0.016)**
Integrated Oil & Gas								
BG GROUP	0.193	0.216	**4.38**	0.01	0.300	-0.024	**3.94**	**7.61**
	(0.114)*	(0.138)	**(0.014)**	(0.912)	(0.155)*	(0.135)	**(0.021)**	**(0.006)**
BP	0.369	0.107	**27.27**	**3.55**	0.164	0.040	2.02	1.14
	(0.097)***	(0.066)	**(0.000)**	**(0.060)**	(0.115)	(0.073)	(0.364)	(0.285)

Table 7 – Continued

	Asymmetric Specification (Model 2)				Scaled Specification (Model 4)			
Firm	β^+_{oil}	β^-_{oil}	$\beta^+_{oil} = \beta^-_{oil} = 0$	$\beta^+_{oil} = \beta^-_{oil}$	β^+_{Voil}	β^-_{Voil}	$\beta^+_{Voil} = \beta^-_{Voil} = 0$	$\beta^+_{Voil} = \beta^-_{Voil}$
ROYAL DUTCH SHELL B	0.344	0.122	**3.85**	0.77	0.165	-0.036	1.23	2.23
	(0.154)**	(0.156)	**(0.023)**	(0.382)	(0.131)	(0.121)	(0.296)	(0.138)

Notes: This Table presents the estimation results of Equation 2 and Equation 4 for 25 firms from the UK transportation, travel and leisure, and oil and gas producers sectors. The figures that are stated in parentheses in the second, third, sixth and seventh columns are standard errors that are asymptotically robust to the existence of heteroscedasticity and serial autocorrelation. The figures that are stated in parentheses in the fourth, fifth, eighth and ninth columns are probabilities. ***, **, and * indicate a statistical significance of 1%, 5% and 10%, respectively.

Table 8: **Effects of oil shocks and recessions on UK firms**

Firm	D_1	**Roil**	$D_1 * Roil$
Transportation			
Transportation Services			
BBA AVIATION	0.004	-0.040	0.016
	(0.011)	(0.068)	(0.133)
BRAEMAR SHIPPING SVS.	-0.002	0.073	0.311
	(0.019)	(0.075)	(0.252)
CLARKSON	-0.012	0.134	0.443
	(0.024)	(0.090)	(0.249)*
FISHER(JAMES) & SONS	-0.027	-0.033	0.179
	(0.017)	(0.073)	(0.143)
OCEAN WILSONS HOLDINGS	-0.012	-0.125	0.369
	(0.016)	(0.088)	(0.176)**
SUTTON HARBOUR HDG.	-0.011	-0.029	0.279
	(0.018)	(0.077)	(0.156)*
Delivery Services			
UK MAIL GROUP	-0.021	-0.192	0.258
	(0.032)	(0.086)**	(0.181)
Travel & Liesure			
Travel & Tourism			
FIRST GROUP	-0.020	0.127	-0.097
	(0.025)	(0.109)	(0.145)
GO-AHEAD GROUP	-0.026	0.007	0.307
	(0.026)	(0.110)	(0.152)**
NATIONAL EXPRESS	-0.043	-0.144	0.441
	(0.019)**	(0.064)**	(0.163)***
STAGECOACH GROUP	-0.042	-0.034	0.524
	(0.020)**	(0.071)	(0.172)***
Airlines			
DART GROUP	0.035	-0.121	-0.798
	(0.038)	(0.101)	(0.612)
EASYJET	-0.032	-0.213	-0.115
	(0.027)	(0.141)	(0.238)

Table 8 – Continued

Firm	D_1	**Roil**	$D_1 * Roil$
Oil & Gas Producers			
Exploration & Production			
AMERISUR RESOURCES	-0.020	0.010	0.546
	(0.033)	(0.198)	(0.343)
CAIRN ENERGY	0.037	0.502	-0.355
	(0.025)	(0.097)***	(0.215)*
FORTUNE OIL	0.037	0.467	-0.256
	(0.028)	(0.140)***	(0.220)
JKX OIL & GAS	-0.021	0.297	0.187
	(0.041)	(0.141)**	(0.269)
NORTHERN PETROLEUM	0.036	0.496	-0.405
	(0.050)	(0.133)***	(0.364)
PREMIER OIL	0.049	0.380	-0.223
	(0.022)**	(0.104)***	(0.244)
SOCO INTERNATIONAL	-0.050	0.255	-0.414
	(0.027)*	(0.132)*	(0.329)
STERLING ENERGY	-0.071	0.252	0.239
	(0.039)*	(0.161)	(0.439)
TULLOW OIL	0.059	0.346	-0.041
	(0.017)***	(0.096)***	(0.175)
Integrated Oil & Gas			
BG GROUP	0.019	0.257	-0.217
	(0.020)	(0.061)***	(0.180)
BP	0.013	0.322	-0.407
	(0.008)	(0.058)***	(0.112)***
ROYAL DUTCH SHELL B	0.011	0.335	-0.477
	(0.012)	(0.071)***	(0.146)***

Notes: This Table presents the estimation results of Equation 5 for 25 firms from the UK transportation, travel and leisure, and oil and gas producers sectors. The figures that are stated in parentheses are standard errors that are asymptotically robust to the existence of heteroscedasticity and serial autocorrelation. ***, **, and * indicate a statistical significance of 1%, 5% and 10%, respectively.

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